MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

PCG0245 – CELLULAR REPRODUCTION AND GENETICS

(Foundation in Life Sciences)

29 FEBRUARY 2016
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **11** printed pages excluding the cover page with **2** sections:
   Section A: 2 Structured Questions
   Section B: 9 Structured Questions
2. Answer **ONE** out of TWO questions in **Section A** and answer **ALL** questions in Section **B.**
3. Distribution of marks for each section/question is given.

SECTION A

STRUCTURED QUESTIONS [10 MARKS]

Instructions: Answer **ONE** out of the **TWO** questions. Write your answers in the answer booklet

Question 1 [10 marks]

a. Paclitaxel is a drug used to treat tumors.
   i. What is a tumor? (1 mark)
   ii. Describe how paclitaxel reduces the risk of developing cancer. (4 marks)

b. In the United States, 16% of the population has Rh negative blood, which is recessive. If the student population of a school is 2000, how many students would you expect to be homozygous dominant? (5 marks)

Question 2 [10 marks]

a. In cats, there is a coat color gene located on the X chromosome. This gene has two alleles – orange and black. A heterozygous cat has tortoiseshell color. A black female cat was crossed with an orange male cat. Predict the genotypic and phenotypic ratio among the offspring of the cross above. Use the letter 'B' for black allele and the letter 'b' for orange allele. Draw a Punnett square to illustrate your answer. (5 marks)

b. In a given population, only 'A' and 'B' alleles are present in the ABO system. There are no individuals with type 'O' blood in this particular population. If 200 people have type A blood, 75 have type AB blood and 25 have type B blood, calculate the frequency for the A allele in this population. (3 marks)

c. **Figure 1** shows an animal cell during prophase I in meiosis.
   i. What is process **U**? (1 mark)
   ii. State the importance of process **U**. (1 mark)

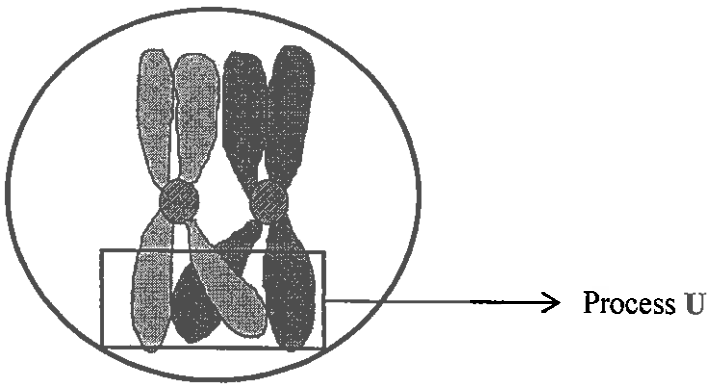

Figure 1

Continued...

SECTION B

STRUCTURED QUESTIONS [90 MARKS]

Instructions: Answer **ALL** questions in this section. Write your answers in the Answer Booklet.

Question 1 [10 marks]

a. **Figure 2** shows the events that happen during fertilization.
   i. Name the parts labeled **C** and **D**. (2 marks)
   ii. Write what happen during events **1**, **2** and **3**. (3 marks)

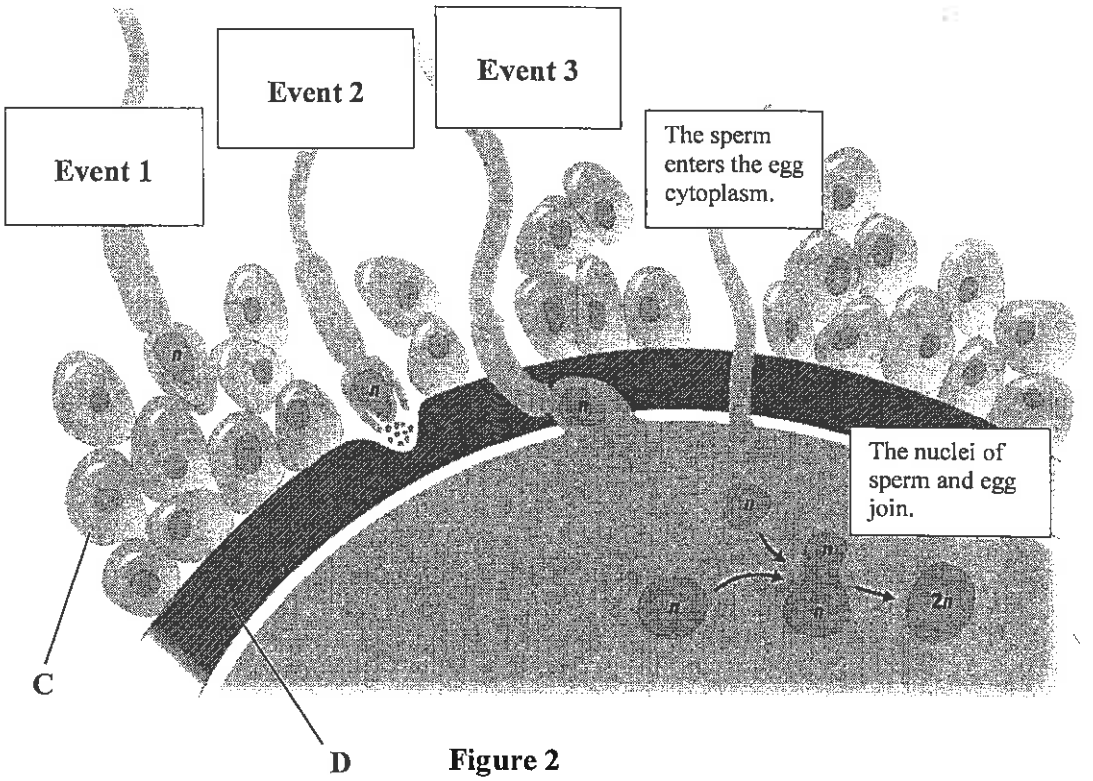

Figure 2

b. **Figure 3** shows a graph of the body temperature of an animal during hibernation.
   i. Define hibernation. (1 mark)
   ii. Why does the body temperature intermittently increase during the months of hibernation? (2 marks)
   iii. Based on the graph in **Figure 3**, state two physiological changes that occurred during the hibernating period. (2 marks)

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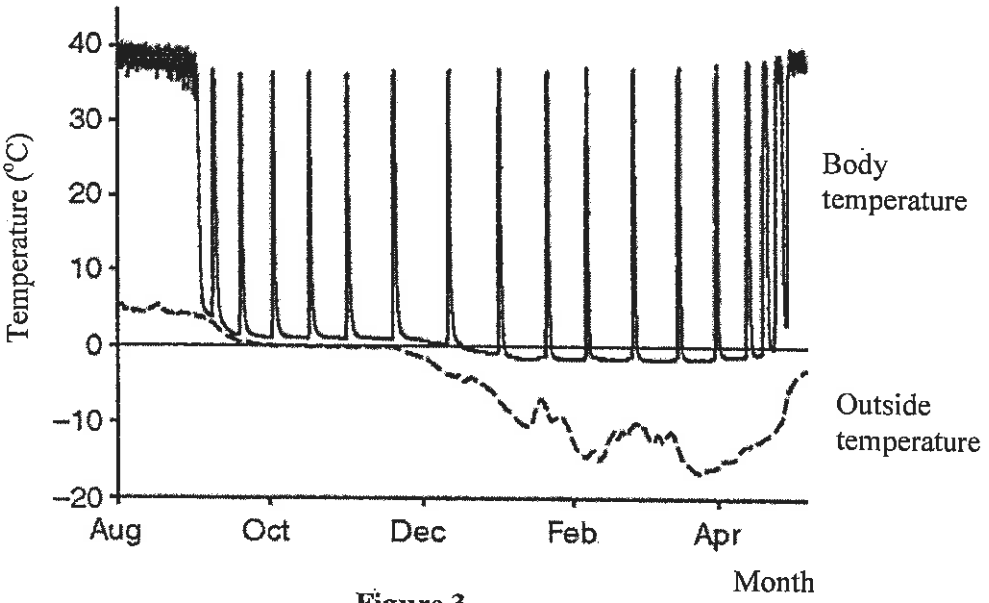


Figure 3

Question 2 [10 marks]

Figure 4 shows the DNA replication fork during DNA replication.

a. When does replication occur in a cell cycle? (1 mark)
b. Name the two enzymes involved in replication and state their function. (4 marks)
c. There are two newly synthesized strands, strand **X** and **Y**. Name both strands and state the way they are synthesized. (2 marks)
d. State why DNA replication is said to be semi conservative. (1 mark)
e. Explain why strand **Y** is synthesized as fragments. (2 marks)

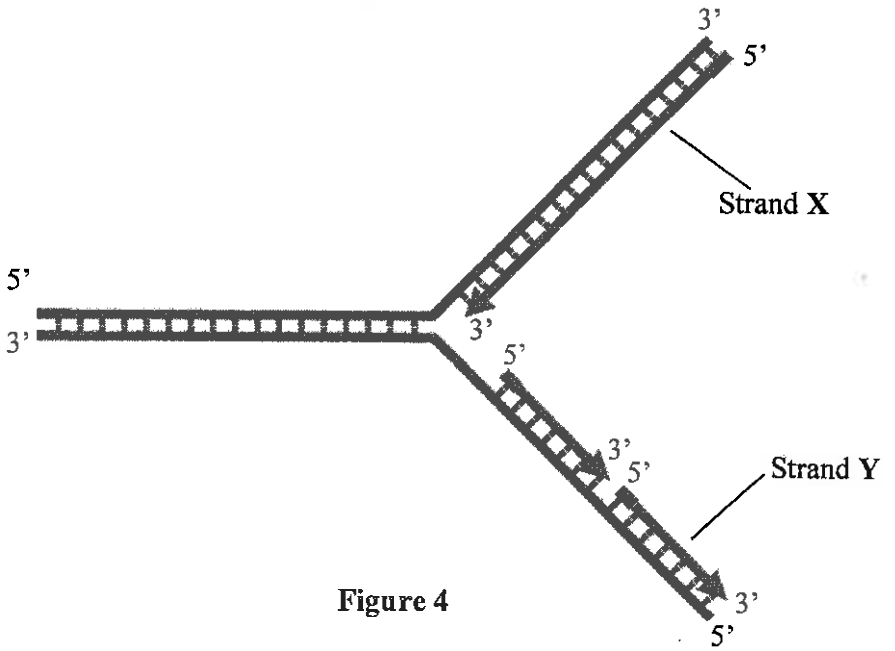


Figure 4

Continued...

Question 3 [10 marks]

a. **Figure 5** shows a hypothetical double stranded DNA sequence, coding for a type of protein. Both strands are shown. The top strand reads 5' to 3' from left to right and the bottom strand reads 5' to 3' from right to left. The nucleotides are numbered from 1 to 20.

i. Which strand is used as a template for transcription, the top or the bottom? (1 mark)

ii. Write the first 15 nucleotides of the resulting mRNA. Indicate the 5' and 3' ends of the mRNA. (2 marks)

iii. Where can you find in the DNA strand (that is numbered from 1 to 20) the nucleotides which codes for a stop codon? (1 mark)

iv. What is the function of the first codon that you have written in a(ii)? (1 mark)

1	10	20
5'-ATGTCCGTCT TATATTGAGA -3'		
3'-TACAGGCAGA ATATAACTCT -5'		

Figure 5

b. **Figure 6** below represents the embryological development of the human.

i. Name the stages labeled **Q** and **R**. (2 marks)

ii. Draw the cross section of the blastocyst and label the inner cell mass. (3 marks)

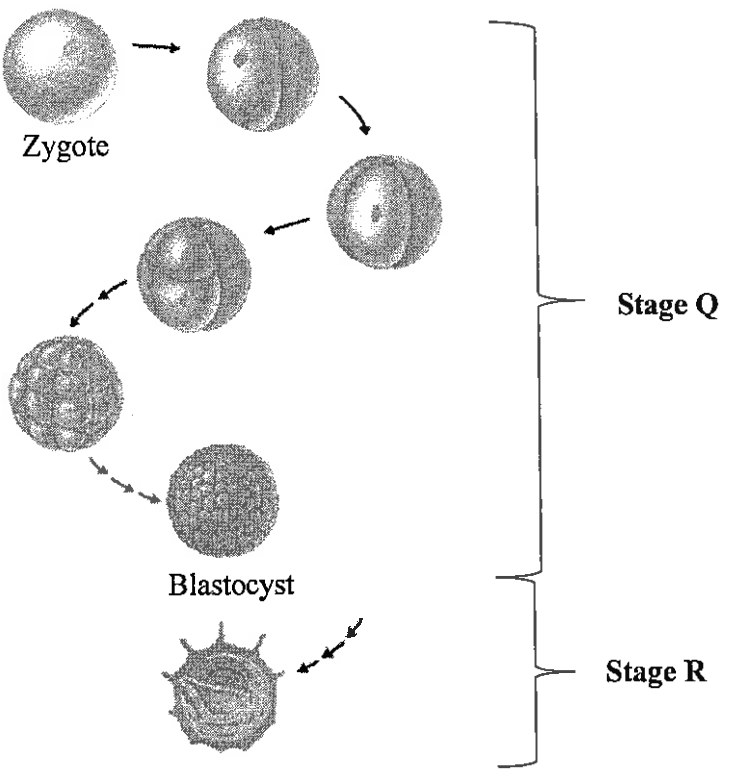


Figure 6

Continued...

Question 4 [10 marks]

a. Recombinant human insulin can be produced by bacteria carrying a cloned insulin gene. The human insulin gene that encodes the mRNA is only 333 nucleotides long but the entire gene is more than 4000 nucleotides. There are 3 exons and 2 introns in the gene. Bacteria are unable to remove the introns.
   i. If the gene is directly cloned from the DNA, bacteria would not be able to express the insulin protein. Explain why. (2 marks)
   ii. The best technique to use in order to get functional insulin is to use the cDNA cloning. Describe briefly how this technique works. (3 marks)

b. **Figure 7** below represents a hypothetical mRNA sequence that encodes for a short protein.
   i. Use the genetic code in **Figure 8** to write the sequence of the amino acid produced. (2 marks)
   ii. If the underlined base is changed from U to A, what would be the effect on the protein? What do we call this kind of mutation? (3 marks)

5' – ACCGUACGACCAUGUCCC – 3'

Figure 7

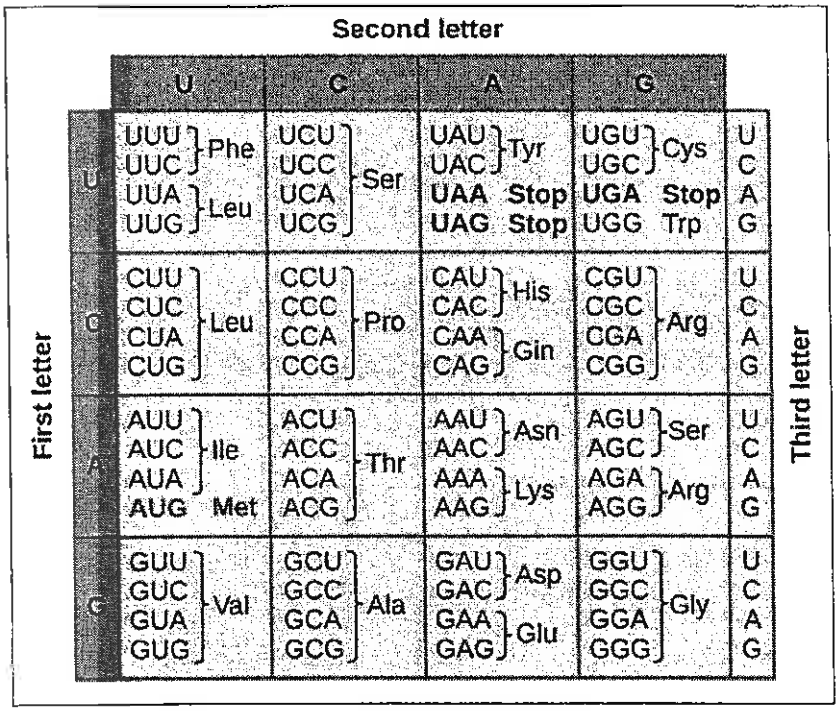


Figure 8

Continued...

Question 5 [10 marks]

a. **Table 1** below records the dry weight changes, in grams, of a sample of soybean seedlings and some of its parts during germination in darkness at the temperature of 25°C.

i. Why does the dry weight of the whole seedling decrease during germination? (1 mark)

ii. Sketch a graph to represent the absolute growth rate. (2 marks)

iii. Give one advantage and one disadvantage of using wet mass as the parameter of growth. (2 marks)

Days	Whole seedling (grams)	Endosperm (grams)	Embryo (radicle and plumule) (grams)
0	224	200	2
1	209	190	3
2	207	188	5
3	205	155	15
4	176	114	23
5	156	83	36

Table 1

b. Night blindness is a condition in which affected people have difficulty seeing in dim light. The allele for night blindness, N, is dominant to the allele for normal vision, n. These alleles are not on the sex chromosome. **Figure 9** below shows part of the family tree showing the inheritance of night blindness.

i. Individual 12 is a boy. What is his phenotype? (1 mark)

ii. What is the genotype of individual 1? Explain the evidence for your answer. (2 marks)

iii. What is the probability that the next child born to individuals 10 and 11 has night blindness? Show your working. (2 marks)

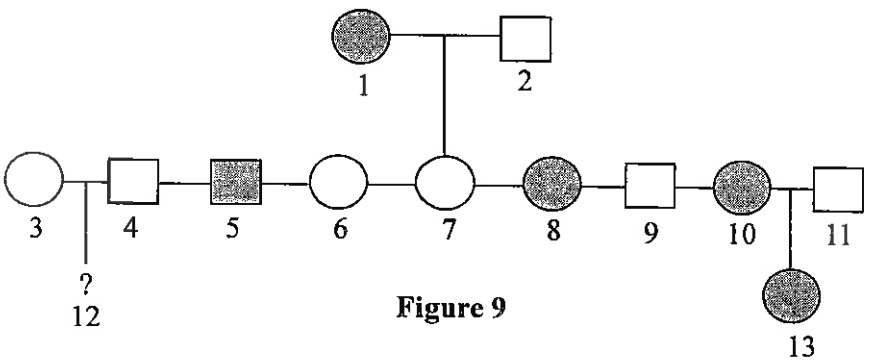
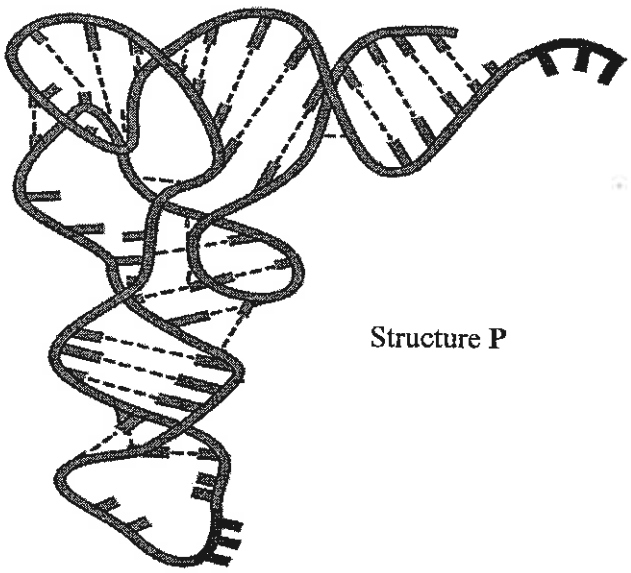


Figure 9

Continued...

Question 6 [10 marks]

a. **Figure 10** below shows a structure which is involved in a synthesis in eukaryotic cell.
   i. Name the structure labeled **P** below. (1 mark)
   ii. Name all the types of bases found in the nucleotides which form structure **P**. (1 mark)
   iii. What is the bond involved in forming and maintaining the 3 dimensional configuration of structure **P**? (1 mark)
   iv. Name the process in which structure **P** is involved. (1 mark)
   v. Name the part of structure P which specifically recognizes a site on the mRNA. (1 mark)



Structure **P**

Figure 10

b. Fill in the blanks with the correct words.
   i. A _____ is an agent which induces a higher rate of mutation. (1 mark)
   ii. _____ is the failure of homologous chromosomes or sister chromatids to separate properly during cell division. (1 mark)
   iii. Individuals with _____ have three copies of chromosome 21. (1 mark)
   iv. A _____ is the movement of a chromosome segment from one chromosome segment to another non homologous chromosome. (1 mark)
   v. During substitution, a nucleotide base pair is replaced by another base pair in the DNA nucleotide sequence of a gene. If a purine replaces a pyrimidine or vice versa, this is a _____. (1 mark)

Continued...

Question 7 [10 marks]

a. Explain why hybrid diploids ($2n$) are infertile but can become fertile following duplication of the chromosome set to become tetraploid ($4n$). (5 marks)

b. **Figure 11** below shows the karyotype of an individual suffering from a certain genetic disorder.
   i. What is a karyotype? (1 mark)
   ii. Name the genetic disorder caused by the chromosomal abnormality as shown in the karyotype below. (1 mark)
   iii. How many chromosomes are found in the somatic cells of this person? (1 mark)
   iv. State two characteristics of a person having this genetic disorder. (2 marks)

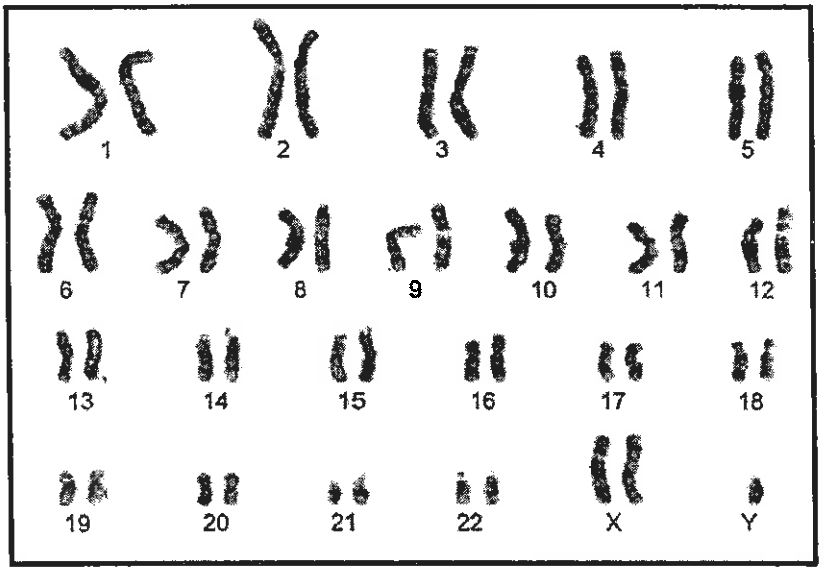


Figure 11

Question 8 [10 marks]

a. Restriction enzymes are commonly used in genetic engineering.
   i. What is a restriction enzyme? (1 mark)
   ii. What is the function of restriction enzymes in the organisms that produce them? (2 marks)
   iii. The restriction site for *Pst* I is shown in **Figure 12** below. The arrows indicate where the enzyme acts. What is produced as a result of the action of *Pst* I and what is the significance of the product formed? (2 marks)

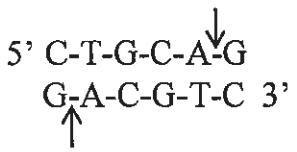


Figure 12

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b. **Figure 13** below shows one method of cloning sheep.
   i. How is the fused cell stimulated to produce an embryo? (1 mark)
   ii. The fusion of body cell from the male sheep and the egg from the female sheep is an example of asexual reproduction. Explain why. (2 marks)
   iii. Give the gender and face color of the cloned lamb. Explain your answer. (2 marks)

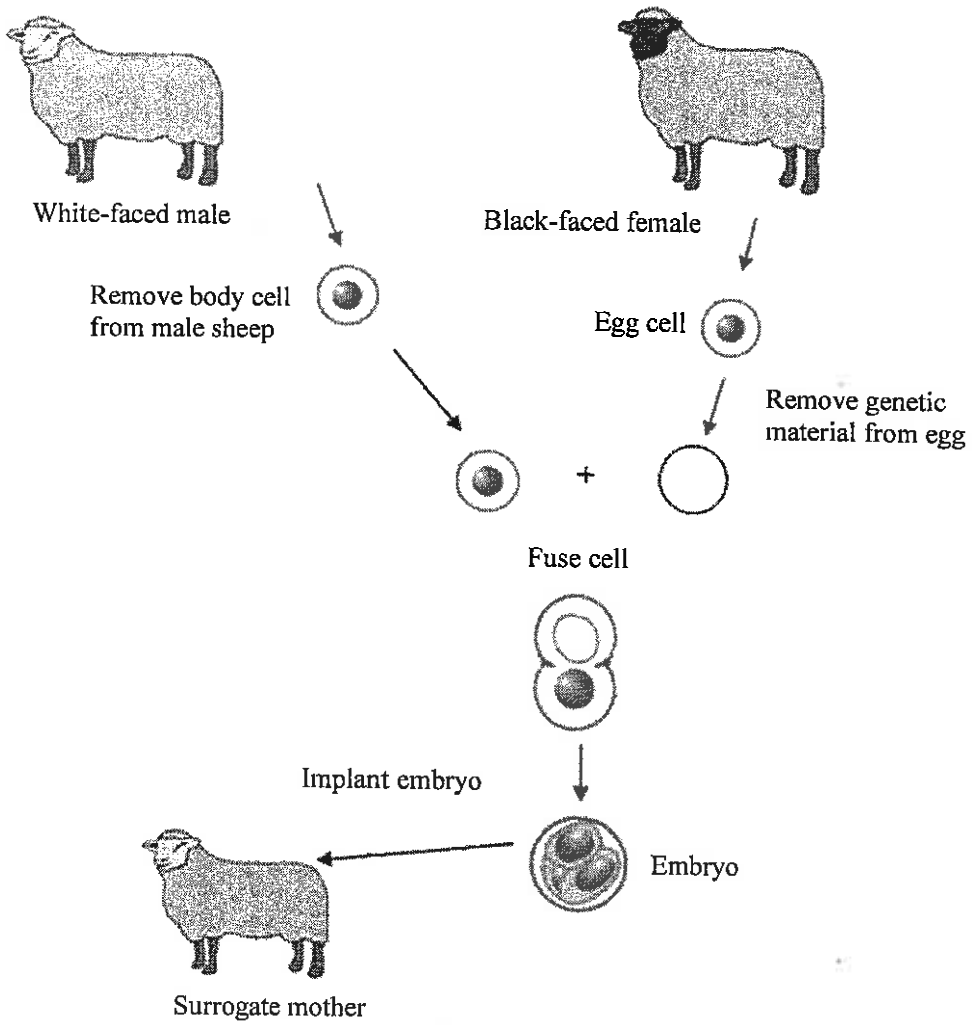


Figure 13

Question 9 [10 marks]

a. **Figure 14** below shows a mature human sperm.
   i. Name the parts labeled **A** and **B**. (2 marks)
   ii. State how the parts **A** and **B** enable the sperm cell to carry out its function. (2 marks)

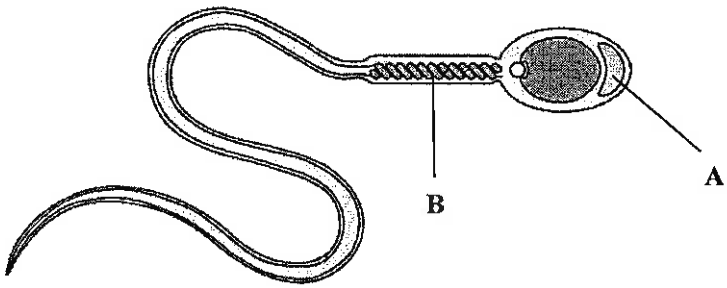
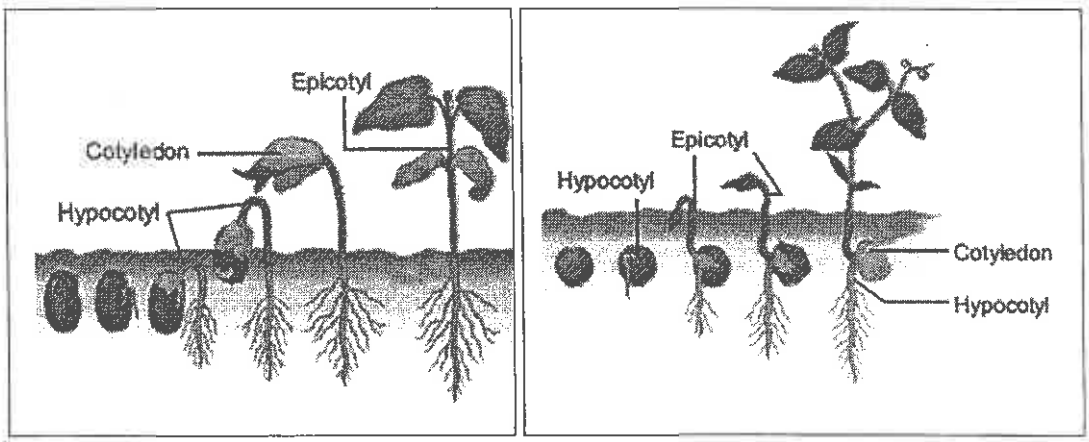


Figure 14

b. **Figure 15** below shows a diagram of seed germination.
   i. State the type of germination of seed **M** and seed **N**. (2 marks)
   ii. Explain the two types of germination below. (2 marks)



Seed M **Seed N**

Figure 15

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c. **Figure 16** below shows the stages in the development of a dicot embryo. Name stages **X** and **Y**. (2 marks)

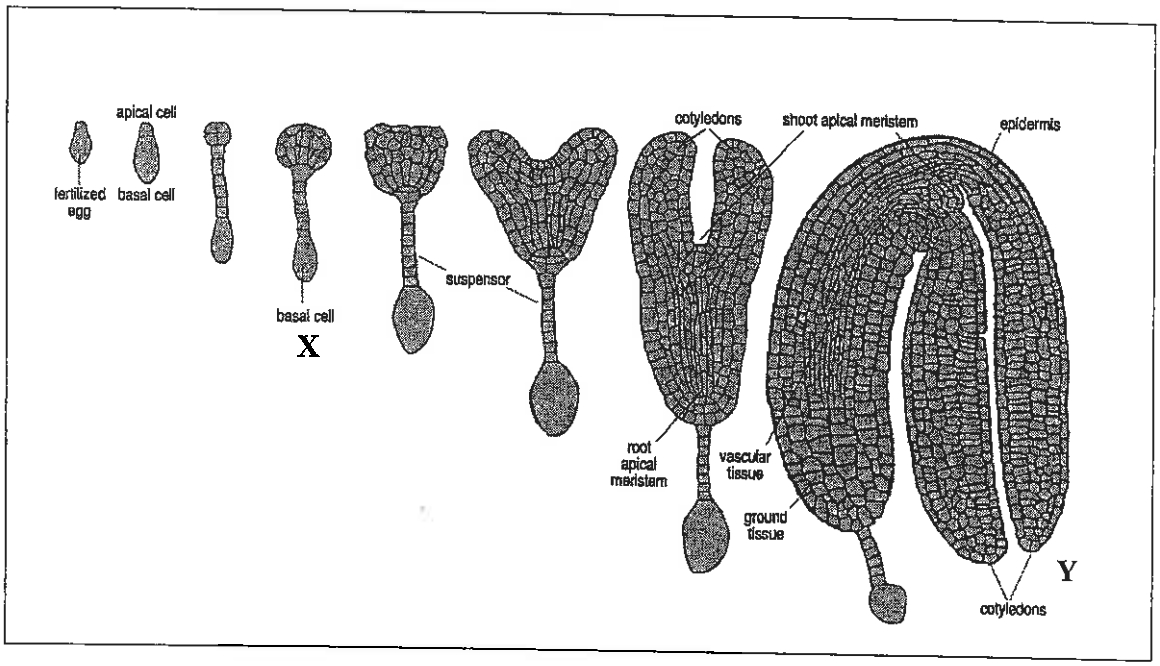

Figure 16

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